Fermilab

January 9, 1996

**To:** Distribution
**From:** C. Jach, G. Krafczyk, D. Wolff
**Subject:** Main Injector Backfeed

After several meetings with members of FESS and Fluor Daniel, several changes have been recommended for the Main Injector backfeed. These recommendations are the result of a better understanding of the practical limitations at the Master Substation (MSS). MI-0122

Feeder 46A was originally proposed to be included in the backfeed to MSS feeders 30, 31, 32, 33, 40, 41, 42, 43, and 44. Because of MSS layout, the cost for reconfiguration of the buswork to accomplish this is high. Adding an additional feeder (three total) from MSS to Kautz Road Substation (KRS) to handle the backfeed for the above mentioned feeders turns out to be a better cost effective solution.

The second limitation to our original work has to do with the total power available at the MSS for transfer to KRS during backfeed. The buswork and tie (main) breakers at the MSS are rated at 2000 Amps RMS. This will limit the total MVA available from each of the MSS transformers to a nominal 47.8 MVA as compared to the 55.8 MVA assumed in our original work.

Attached please find revised figures and charts showing the results of these latest modifications to the backfeed recommendations as well as a new cost estimate for the Main Injector work as currently proposed. *Please be aware that additional MSS costs for buswork reconfiguration of approximately $350K will be needed to fully realize the capability of these recommendations.* Since work on the Kautz Road Substation specifications and drawings are nearing completion, Fluor Daniel will need to make final changes to the KRS plans as soon as possible. Please contact Cezary Jach if you have questions regarding this final approach to the backfeed issue.

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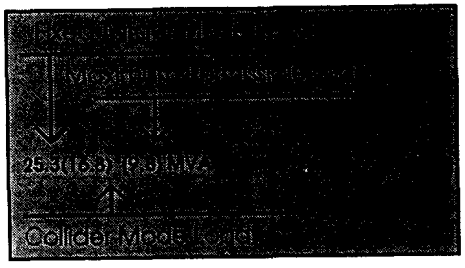
# MAIN INJECTOR ERA
# BACKFEED RECOMMENDATIONS

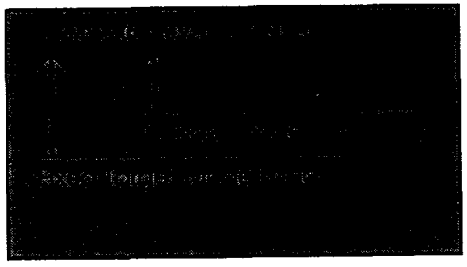
Cezary Jach
January 1996

## Bus Load Nomenclature



* - (16.8) if omitted, assume same load as Fixed Target Mode load - 25.3 MVA

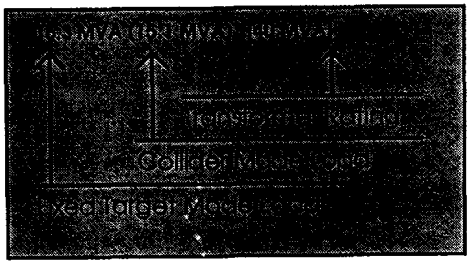
## Feeder Load Nomenclature



* - (5.1) if omitted, assume same load as Fixed Target Mode load - 6.3 MVA

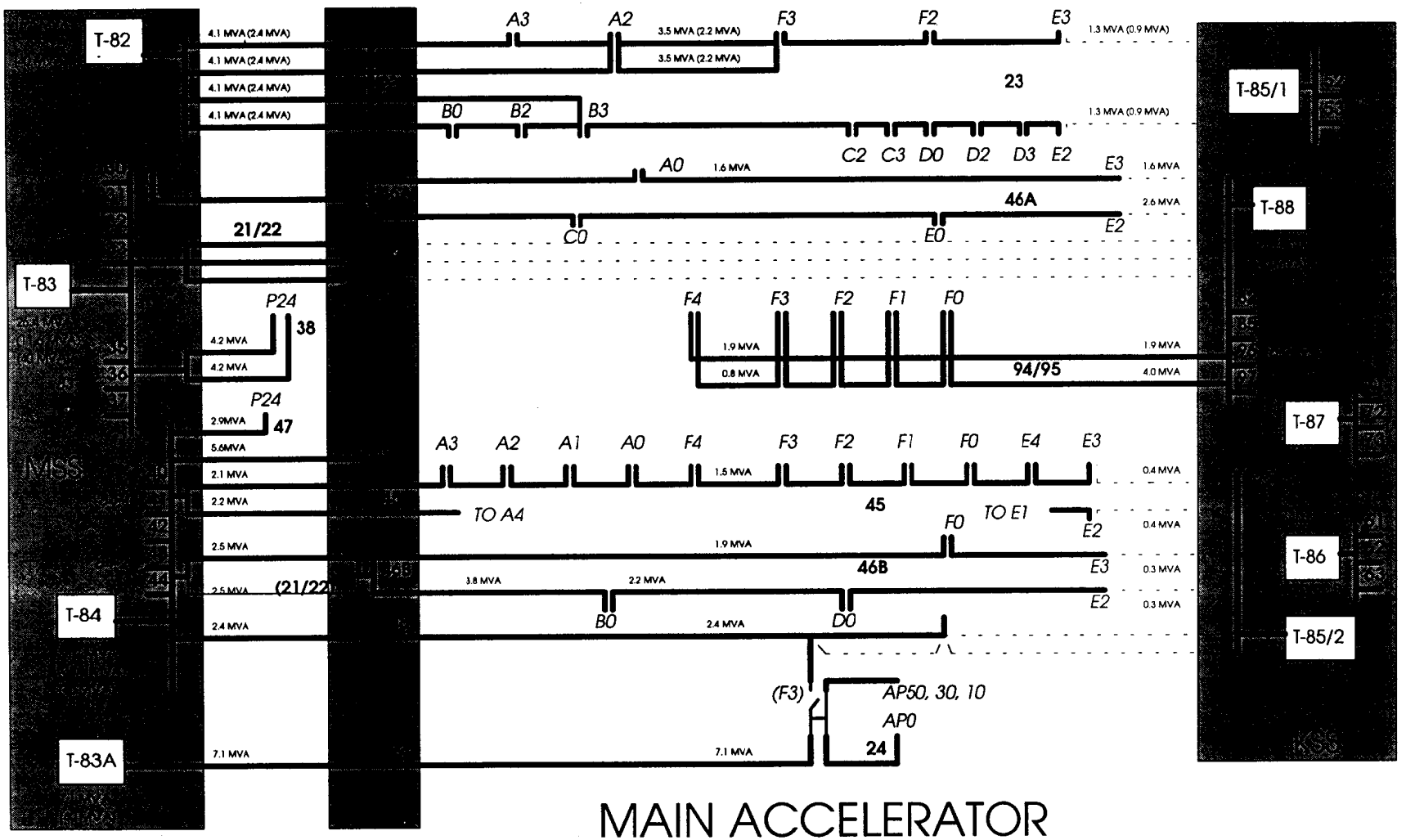
** - {7.2 MVA} is 750 MCM, AL cable maximum permissible load (same for all cables - therefore omitted in all figures)

## Transformer Load Nomenclature



* - (15.1) if omitted, assume same load as Fixed Target Mode load - 16.3 MVA

| Estimated Feeder Loads for Different Accelerator Operating Modes | | | | | |
|---|---|---|---|---|---|
| *Feeder* | *Feeder Designation* | *COLLIDER MODE* | | *FIXED TARGET MODE* | |
| *Number* | | *MVA* | *PF* | *MVA* | *PF* |
| 23 | Tev Pulsed PWR | 12.50 | 0.720 | 19.10 | 0.750 |
| 24 | P-Bar | 7.11 | 0.733 | 7.11 | 0.733 |
| 30 | Meson | 0.46 | 0.890 | 2.56 | 0.890 |
| 31 | Meson | 0.46 | 0.890 | 2.76 | 0.890 |
| 32 | Neutrino | 0.49 | 0.890 | 2.81 | 0.890 |
| 33 | Neutrino | 0.20 | 0.890 | 1.98 | 0.890 |
| 35 | Neutrino | 0.91 | 0.890 | 2.32 | 0.890 |
| 36 | Proton | 0.48 | 0.890 | 2.73 | 0.890 |
| 37 | Proton | 0.28 | 0.890 | 2.97 | 0.890 |
| 38 | B0 Compressor/CHL | 8.38 | 0.835 | 8.38 | 0.835 |
| 40 | Transfer Gallery/Linac | 4.02 | 0.695 | 4.02 | 0.695 |
| 41 | Booster | 4.33 | 0.789 | 4.33 | 0.789 |
| 42 | CUP | 3.63 | 0.799 | 3.63 | 0.799 |
| 43 | Transfer Gallery | 0.81 | 0.890 | 1.97 | 0.890 |
| 44 | Central Laboratory | 2.37 | 0.761 | 2.37 | 0.761 |
| 45 | Main Ring Conventional Power | 4.40 | 0.840 | 4.40 | 0.840 |
| 46A | Main Ging Compressors | 4.29 | 0.815 | 4.29 | 0.815 |
| 46B | Main Ging Compressors | 5.04 | 0.833 | 5.04 | 0.833 |
| 47 | Industrial Buildings | 2.88 | 0.834 | 2.88 | 0.834 |
| 48 | RF | 2.40 | 0.900 | 2.40 | 0.900 |
| 49 | Central Compressor/B0/D0 | 5.63 | 0.817 | 5.63 | 0.817 |
| 52/53 | Main Injector Conventional Power | 7.90 | 0.890 | 7.90 | 0.890 |
| 61,62,63 | Main Injector Pulsed Power | 27.40 | 0.800 | 27.40 | 0.800 |
| 71,72,73 | Main Injector Pulsed Power | 27.40 | 0.800 | 27.40 | 0.800 |
| 82/85 | Main Injector RF Pulsed Power | 6.50 | 0.800 | 6.50 | 0.800 |
| 96/97 | Main Injector Beam Line Power | 2.40 | 0.800 | 2.40 | 0.800 |
| 94/95 | Main Injector Beam Line Power | 6.00 | 0.800 | 6.00 | 0.800 |



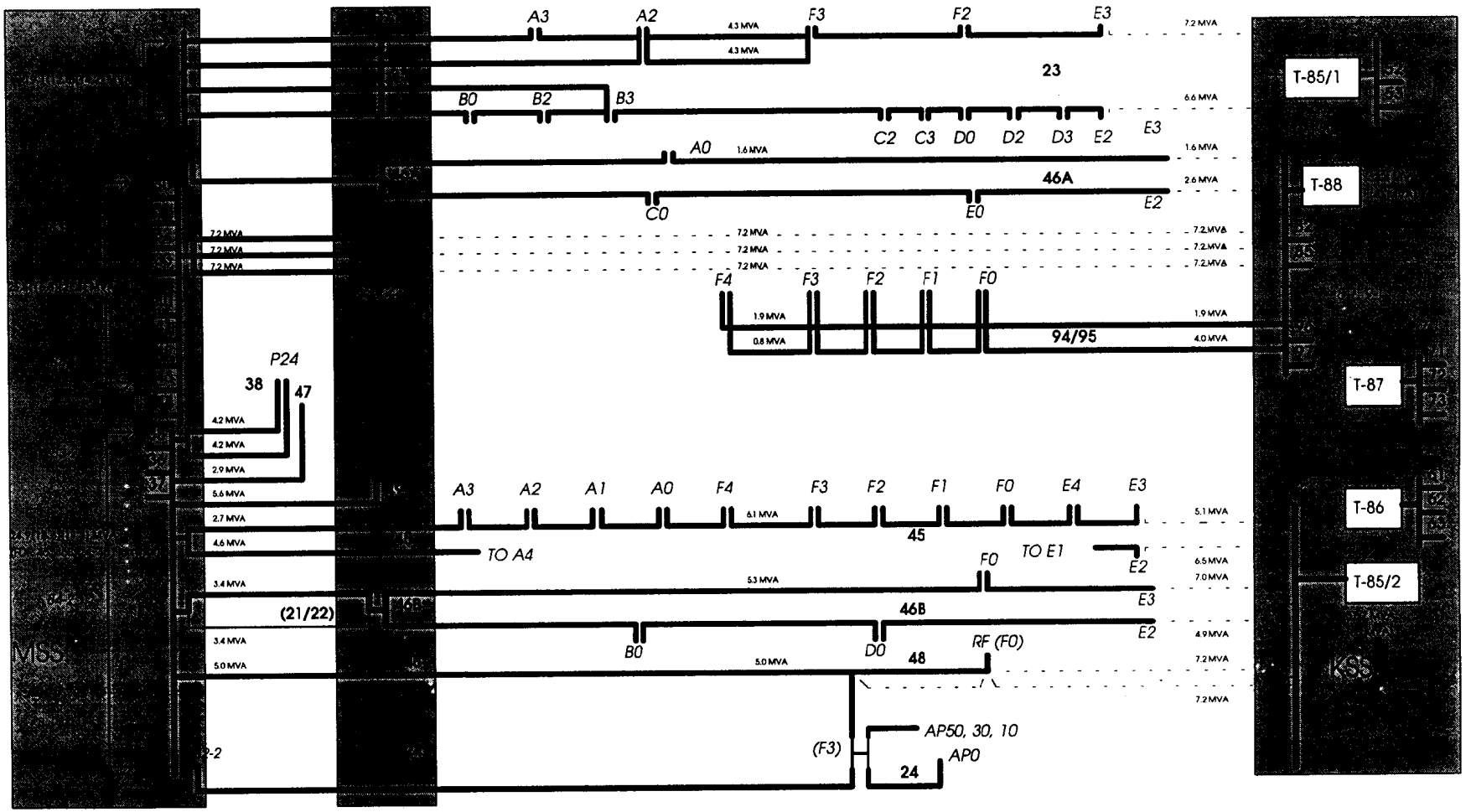

# MAIN ACCELERATOR

DUCT CAPACITY = 18 X 5.5 = 99 MVA
COLLIDER MODE LOAD = 45 MVA
FIXED TARGET MODE LOAD = 52 MVA

DUCT CAPACITY = 12 X 5.5 = 66 MVA
COLLIDER MODE LOAD = 22 MVA
FIXED TARGET MODE LOAD = 24 MVA

FIXED TARGET MODE LOAD = 14 MVA
DUCT CAPACITY = 18 X 5.5 = 99 MVA
COLLIDER MODE LOAD = 13 MVA

## NORMAL OPERATION - MAIN INJECTOR ERA



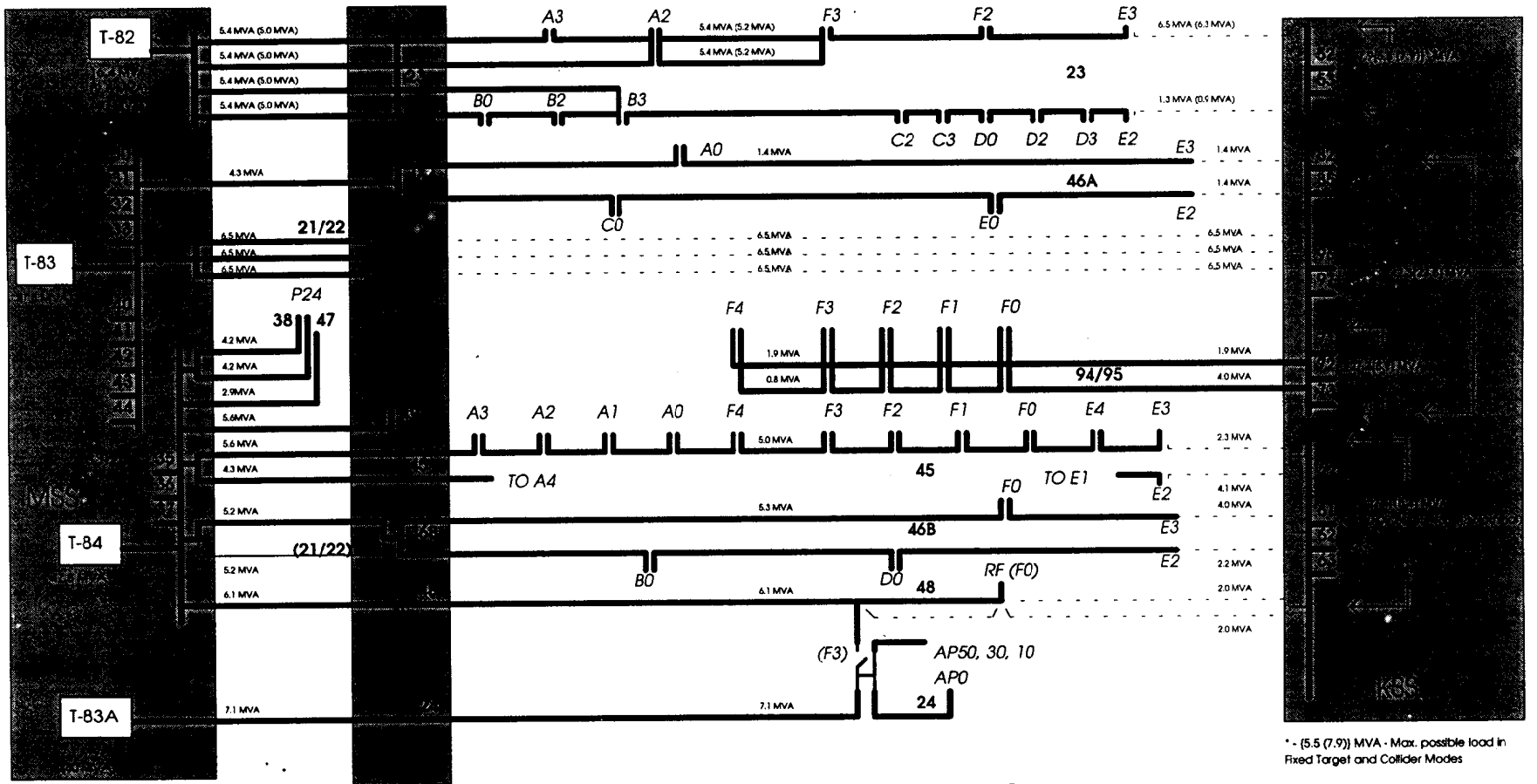

# MAIN ACCELERATOR

↑
DUCT CAPACITY = 18 X 5.5 = 99 MVA
MAXIMUM LOAD = 58 MVA

↑
DUCT CAPACITY = 12 X 5.5 = 66 MVA
MAXIMUM LOAD = 51 MVA

↑
DUCT CAPACITY = 18 X 5.5 = 99 MVA
MAXIMUM LOAD = 84 MVA

Backfeed Configuration MSS ← KSS




* - (5.5 (7.9)) MVA - Max. possible load in Fixed Target and Collider Modes

# MAIN ACCELERATOR

* - 47.8 MVA - limitation due to 2,000 A bus (breaker) rating

DUCT CAPACITY = 18 X 5.5 = 99 MVA
MAXIMUM LOAD = 80 MVA

DUCT CAPACITY = 12 X 5.5 = 66 MVA
MAXIMUM LOAD = 58 MVA

DUCT CAPACITY = 18 X 5.5 = 99 MVA
MAXIMUM LOAD = 52 MVA

Backfeed Configuration MSS ⟶ KSS

| KSS TO MSS BACKFEED | | | | | |
|---|---|---|---|---|---|
| FEEDER NUMBERS | Collider Nominal | MVA | Fixed Target Nominal | MVA | Maximum Available MVA |
| 23 | 12.5 | 12.5 | 19.1 | 19.1 | 12.1 |
| 24 | 7.1 | 37.4 | 7.1 | 43.7 | 36.3 |
| 35,36,37 | 1.7 | | 8.0 | | |
| 38,47,48,49 | 19.3 | | 19.3 | | |
| 45,46B | 9.4 | | 9.4 | | |
| 30,31,32,33 | 1.6 | 16.7 | 10.1 | 26.2 | 21.6 |
| 40,41,42,43,44 | 15.1 | | 16.2 | | |
| 46A | 4.3 | 4.3 | 4.3 | 4.3 | 4.3 |
| | | | | | **71.7** |
| **MSS TO KSS BACKFEED** | | | | | |
| 52,53 | 7.9 | 7.9 | 7.9 | 7.9 | 5.5 (14.4*) |
| 82,83,84,85 | 6.5 | 42.3 | 6.5 | 42.3 | 16.4 |
| 94,95 | 6.0 | | 6.0 | | |
| 96,97 | 2.4 | | 2.4 | | |
| 71,72,73 | 27.4 | | 27.4 | | |
| 61,62,63 | 27.4 | 27.4 | 27.4 | 27.4 | 15.9 |
| | | | | | **36.5** |

* These feeders, supplied by the TEV #23 feeder, will have a maximum available capacity of 14.4 MVA in collider mode and 5.5 MVA in fixed target mode.

## Required Work*

| | | |
|---|---|---|
| 1. | Extend Feeder #23 2,000 feet from E2 to KSS and back to E3 | $40K |
| 2. | Extend Feeder #45 2,000 feet from E2 to KSS and back to E3 | $40K |
| 3. | Extend Feeder #46A 2,000 feet from E2 to KSS and back to E3. | $40K |
| 4. | Extend Feeder #46B 2,000 feet from E2 to KSS and back to E3, Re-terminate and re-connect 1 of the 4 21/22 feeders from P71 to MSS that will be run in parallel with this run of 46B. | $48K |
| 5. | Extend Feeder #21/22 17,000 feet from P71 to KSS. This will be a triple feeder from MSS Bus 84-1 to KSS bus 8-1. | $474K |
| 6. | Extend Feeder #48 2 x 1,000 feet to make it a double feeder from KSS to F0. | $43K |
| 7. | Add additional 2,100 feet to Feeder #48 to make it a double feeder from F3 to F0. | $44K |
| | **Total** | **$729K** |

* Estimated prices include materials and labor. FNAL costs for specification preparation and project oversite are not included.

## KSS TO MSS BACKFEED

| FEEDER NUMBERS | Collider Nominal MVA | | | Fixed Target Nominal MVA | | | Configuration (Maximum Available MVA) MINIMUM | RECOMMENDED |
|---|---|---|---|---|---|---|---|---|
| 23 | 12.5 | 19.6 | 12.5 | 19.1 | 26.2 | 19.1 | 12.1 | 12.1 |
| 24 | 7.1 | | 36.6 | 7.1 | | 42.9 | | 36.3 |
| 35,36,37 | 1.7 | 29.6 | | 8.0 | 35.9 | | 24.1 | |
| 38,47,48,49 | 19.3 | | | 19.3 | | | | |
| 45,46B | 9.4 | | | 9.4 | | | | |
| 30,31,32,33 | 1.6 | 17.7 | 17.7 | 10.1 | 31.3 | 31.3 | 14.2 | 27.6 |
| 40,41,42,43,44 | 15.1 | | | 16.2 | | | | |
| 46A | 4.3 | | | 4.3 | | | | |
| **Backfeed Total [MVA]** | | | | | | | **50.4** | **75.0** |

## MSS TO KSS BACKFEED

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 52,53 | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 | 5.5* | 5.5* |
| 82,83,84,85 | 6.5 | 14.9 | 42.3 | 6.5 | 14.9 | 42.3 | 9.6 | 17.5 |
| 94,95 | 6.0 | | | 6.0 | | | | |
| 96,97 | 2.4 | | | 2.4 | | | | |
| 71,72,73 | 27.4 | 54.8 | | 27.4 | 54.8 | | 14.4 | |
| 61,62,63 | 27.4 | | 27.4 | 27.4 | | 27.4 | | 16.2 |
| **Backfeed Total [MVA]** | | | | | | | **35.6** | **38.6** |

* These feeders are supplied by the TEV #23 feeder and their is no limitation during collider running and a 5.5MVA limit during fixed target running.

## Required Work

**Minimum Configuration :**

| | |
|---|---|
| 1. Extend Feeder #23 2,000 feet from E2 to KSS and back to E3 | $40K |
| 2. Extend Feeder #45 2,000 feet from E2 to KSS and back to E3 | $40K |
| 3. Extend Feeder #46A 2,000 feet from E2 to KSS and back to E3, Re-terminate and re-connect 1 of the 4 21/22 feeders from P71 to MSS that will be run in parallel with this run of 46A. | $48K |
| 4. Extend Feeder #46B 2,000 feet from E2 to KSS and back to E3, Re-terminate and re-connect 1 of the 4 21/22 feeders from P71 to MSS that will be run in parallel with this run of 46B. | $48K |
| **Total** | **$176K** |

**Recommended Configuration**

| | |
|---|---|
| 1. Minimum Configuration | $176K |
| 2. Extend Feeder #21/22 17,000 feet from P71 to KSS. This will be a double feeder from MSS Bus 84-1 to KSS bus 8-1. | $316K |
| 3. Extend Feeder #48 2 x 1,000 feet to make it a double feeder from KSS to F0. | $43K |
| 4. Add additional 2,100 feet to Feeder #48 to make it a double feeder from F3 to F0. | $44K |
| **Total** | **$579K** |